

REMARKS

An Excess Claim Fee Payment Letter is submitted hereto to cover the cost of any excess claims added by this Amendment.

Claims 14-38 are all of the claims presently pending in the Application. Claims 14, 19 and 21 have been amended to further define the invention. Claims 26-38 have been added to claim additional features of the invention. Attached hereto is a marked-up version of the changes made to the claims by the current Amendment.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 21, 24 and 25 stand rejected upon informalities (e.g., 35 U.S.C. § 112, first and second paragraph). Claims 14-16, 19 and 21-24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nemoto et al. (U.S. Patent No. 6,025,213) in view of Tsutsui (U.S. Patent No. 5,798,536). Claims 17, 18 and 25 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nemoto et al. in view of Tsutsui and further in view of Shimizu (Japanese Patent No. 408007614). Claim 20 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Nemoto et al. in view of Tsutsui and further in view of Vriens et al. (U.S. Patent No. 5,813,753).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention (e.g., as recited in claim 14) is directed to a semiconductor light-emitting apparatus of a flip chip bonding-type. The apparatus may include a transparent base including an inorganic material which has on one side thereof a first bonding pad and a second bonding pad to be connected to a pair of lead frames with a space between the first and the second bonding pads where a semiconductor light-emitting element is fixed. Further, the light-emitting element may include a light-emitting layer, a substrate disposed between the light emitting layer and the base, and a positive electrode.

Specifically, the positive electrode may be disposed on an opposite side of the light-emitting layer from the substrate and reflecting light from the light-emitting layer in a direction through the substrate and the base. This feature is important because it may help to prevent a sealing resin in the dominant light-emitting path from becoming discolored due to heat generated by the light emitting element. In addition, as exemplarily defined by dependent claims 10-12 and 17-18, it allows a fluorescent material to be incorporated into the base to provide a light-emitting apparatus in which light of a constant color can be emitted for an extended period of time.

In addition, this novel features allows the use of bonding wires for connecting the electrodes of the light-emitting element to the bonding pads on the base. This allows the bonding pads to be formed on the base so as to maximize a distance between the lead frames, which facilitates attachment of the lead frames to the bonding pads.

In another embodiment of the claimed invention, as defined by independent claim 21, a light-emitting diode includes a sapphire substrate, a light emitting layer made of GaN semiconductor and formed on the sapphire substrate, and a positive electrode and a negative electrode electrically coupled to the light emitting layer. The positive electrode and negative electrode are supplied with electricity through a wire. Importantly, the positive electrode has a thickness of at least 300 Å to prevent light leakage, includes a reflective material for reflecting light from the light emitting layer toward the sapphire substrate, and covers substantially an entire surface of the light-emitting layer. This feature is important because it helps to ensure that light emitted in a non-dominant light-emitting direction may be reflected back by the positive electrode (e.g., in a dominant light-emitting direction).

The prior art references do not appear to teach or suggest these novel features.

II. THE 35 U. S. C. §112, FIRST AND SECOND PARAGRAPH REJECTIONS

The Examiner alleges that claims 21, 24 and 25 are not enabled and are indefinite. Applicant submits, however, that these claims are adequately enabled and are clearly and distinctly claim the subject matter regarded as the invention.

Specifically, Applicant notes that claim 21 has been amended to delete the phrase "*on which the sapphire substrate is not formed*", which should address the concerns of the

Examiner.

III. THE PRIOR ART REFERENCES

A. The Nemoto and Tsutsui References

The Examiner alleges that Nemoto would have been combined with Tsutsui to form the claimed invention (e.g., as claimed in claims 14-16, 19 and 21-24). Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention

Nemoto discloses a surface-emission semiconductor light-emitting device package that is intended to radiate heat from the front surface while emitting light to the front surface of the device. The package includes a semiconductor light-emitting device for emitting light to a semiconductor substrate in the upper direction and a package window portion formed of a transparent heat sink. The device is bonded to the package window portion in accordance with an interconnection pattern (Nemoto at Abstract).

The Examiner admits that Nemoto does not disclose each and every feature of the claimed invention. However, the Examiner alleges that Nemoto would have been combined with Tsutsui to form the claimed invention.

Tsutsui discloses a light-emitting semiconductor device with a light-emitting chip having an insulator substrate and a semiconductor layer formed over the substrate. A top electrode is formed on a surface of the first conductivity type region. An end electrode is formed on an exposed surface of the second conductivity type region. A first electrode lead is mounted with the light-emitting chip and has a projecting portion extending along an adjacent surface of the light-emitting chip. A second electrode lead extends parallel to the first electrode lead. A conductor wire is electrically connected between the second electrode lead and the top electrode. The end electrode and the projecting portion are electrically connected through an electricity-conductive resin (Tsutsui at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems. Specifically, Nemoto is intended to address heat problems in a light-emitting device package (Nemoto at col. 2, lines 20-27) whereas Tsutsui is intended to improve the connection

between electrodes on a light-emitting chip (Tsutsui at col. 2, lines 36-41). Therefore, no person of ordinary skill in the art would have considered combining these references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner supports the combination by merely stating that “[i]t would have been obvious ... to use a light-emitting chip ... in Nemoto’s invention since GaN based light emitting diodes are a common light emitting element and are easily substitutable into Nemoto’s invention so that a light emitting device of excellent light properties may be obtained” which is insufficient to support the combination.

Moreover, neither Nemoto nor Tsutsui teaches or suggests “*a positive electrode comprising a light non-transmissible material, said electrode being disposed on an opposite side of said light-emitting layer from said substrate and reflecting light from said light-emitting layer in a direction through said substrate and said base*”, as recited in claims 14 and 19, nor a positive electrode which “*has a thickness of at least 300 Å*” and “*comprises a light non-transmissible material for reflecting light from said light emitting layer toward said sapphire substrate*” as recited in claim 21.

Conventional light-emitting devices having a “flip-chip” design may include light-emitting diodes with positive and negative electrodes which are mounted directly on the lead frames by soldering (Application at page 2, lines 18-21). However, in such devices a sealing resin in the dominant light-emitting path may become discolored due to heat generated by the light emitting element (Application at page 3, lines 11-23). In addition, in these devices it is difficult to fix the electrodes on the mounts of lead frames with positioning accuracy in the order of microns (Application at page 3, lines 1-10).

The claimed invention, on the other hand, includes a light-emitting element which may include a positive electrode including a light non-transmissible material, the electrode being disposed on an opposite side of the light-emitting layer from the substrate and reflecting light from the light-emitting layer in a direction through the substrate and the base (Application at Figure 1). As noted above, this feature is important because it may help to prevent a sealing resin in the dominant light-emitting path from becoming discolored due to heat generated by the light emitting element (Application at page 6, lines 2-11). In addition,

it allows a fluorescent material to be incorporated into the base to provide a light-emitting apparatus in which light of a constant color can be emitted for an extended period of time (Application at page 7, lines 18-23).

In addition, this novel feature allows the use of bonding wires for connecting the electrodes of the light-emitting element to the bonding pads on the base. This allows the bonding pads to be formed on the base so as to maximize a distance between the lead frames, which facilitates attachment of the lead frames to the bonding pads (Application at page 6, line 12-page 7, line 17).

Clearly, the references do not teach or suggest these novel features. Indeed, neither of these references discusses the problems that the claimed invention seeks to address which include the problems with heat-induced color change of sealing resin in the dominant light-emitting path, and difficulty involved with accurately connecting electrodes to the lead frames.

Specifically, referring to Figure 15E (on which the Examiner relies), Nemoto discloses a device in which a light coupled device 51 is bonded to interconnection patterns 41 on the surface of a package window portion 32. Further, lead frames 58 are bonded to electrode pads 42 affixed to the same surface (Nemoto at Figure 15E; col. 10, lines 47-62).

However, in Nemoto the electrodes 77, 78 of the light coupled device 51 are directly bonded to the package window portion 32 through solder layers 43A, 43B. In other words, Nemoto clearly does not teach or suggest a light-emitting element having a first electrode disposed on an opposite side of the light-emitting layer from the base and reflecting light from the light-emitting layer through the base.

Further, in the Nemoto device, since the electrodes 77, 78 are directly bonded to the package, bonding wires cannot be used to electrically connect the device 51 so as to increase (e.g., maximize) the distance between the lead frames 58. Therefore, like the conventional devices discussed in the Background section of the Application, in the Nemoto device it would be difficult to accurately connect the lead frames 58 to the bonding pads 42.

Moreover, in the Nemoto device, the dominant light emitting direction is not through the substrate 66, but is in a direction away from the substrate 66 as a result of the reflector 67 formed in the device 51 (Nemoto at col. 9, lines 12-19). Thus, it would clearly not be reasonable to modify the Nemoto device so that the substrate 66 of the light coupled device 51 is connected to the package window portion 32, because it would reverse the dominant

light-emitting direction of the Nemoto device. Thus, the Examiner's reliance on Tsutsui teaches away from the claimed invention.

Thus, Nemoto does not disclose a positive electrode which includes a light non-transmissible material and which reflects light in a dominant light-emitting direction. Indeed, as noted above, the dominant light-emitting direction in Nemoto is not through the substrate, but is away from the substrate 66. In other words, Nemoto would not want a reflective electrode because it would reflect light away from the dominant light-emitting direction.

Therefore, Nemoto clearly does not teach or suggest "*wherein said positive electrode has a thickness of at least 300 Å*" and "*comprises a light non-transmissible material for reflecting light from said light emitting layer toward said sapphire substrate*", as recited in claim 21.

Similarly, Tsutsui does not teach or suggest the novel features of the claimed invention. The Examiner relies on Figure 7(a) in Tsutsui to support his allegations. Figure 7(a) shows a light-emitting chip 21 formed on a base 24, and one lead 25 connected to the opposite side of the base 24, and another lead 26 which is not connected at all to the chip 21. The device also includes gold wires 27, 28 connecting the chip electrodes 22, 23 to the parallel-extending electrode leads 25, 26 (Tsutsui at Figure 7(a); col. 1, lines 32-56).

However, unlike the claimed invention, the Tsutsui device does not include a light-emitting element having an electrode ... reflecting light from the light-emitting layer through the base. For example, Figure 6 shows light emitted from the light-emitting region toward the substrate 1a is reflected by the reflection film 11 ahead of the device, thereby intensifying the light radiation (Tsutsui at col. 8, lines 4-10). The positive electrode would be formed on the layer 13. Therefore, the Tsutsui discloses a device having a dominant light-emitting direction which is from the light-emitting region toward the positive electrode (i.e., through the positive electrode). In other words, the dominant light emitting direction is not through the substrate (e.g., not through the base).

Therefore, Tsutsui would not want a reflective electrode because it would reflect light away from the dominant light-emitting direction. Thus, Tsutsui clearly does not teach or suggest a positive electrode having "a thickness of at least 300 Å" to prevent light leakage and "a light non-transmissible material for reflecting light from said light emitting layer toward said sapphire substrate" as recited in claim 21. Thus, the Tsutsui device is completely unrelated to the claimed invention, and Tsutsui fails to make up for the deficiencies of

Nemoto.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Shimizu Reference

The Examiner alleges that Shimizu would have been combined with Nemoto and Tsutsui to form the claimed invention (e.g., as claimed in claims 17, 18 and 25). We would argue, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Shimizu discloses sheet-like light source in which light emitted from a blue light emitting diode (LED) is partially radiated to an external part except a light conductive plate 2 in the vicinity of the tip, but most light reaches an end surface of the light conductive plate 2 while repeating total reflection in the light conductive plate 2. The LED can be used mainly as a back light and can emit white light. (Shimizu at Abstract).

However, we would argue that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different matters. Specifically, as noted above, Nemoto is intended to address heat problems in a light-emitting device package, and Tsutsui is intended to improve the connection between electrodes on a light-emitting chip, whereas, Shimizu is directed to a light source which can emit a white light. Therefore, no person of ordinary skill in the art would have considered combining these references.

Further, we would argue that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner supports the combination by merely stating that “[i]t would have been obvious ... to include this fluorescent layer in the light coupled device of Nemoto in view of Tsutsui so that the light emitted from the fluorescent layer provide complementary additive colors so that white light is emitted” which is insufficient to support the combination.

Moreover, we would argue that Shimizu does not make up for the deficiencies of Nemoto and Tsutsui discussed alone. Specifically, Shimizu does not teach or suggest “*a positive electrode comprising a light non-transmissible material, said electrode being*

disposed on an opposite side of said light-emitting layer from said substrate and reflecting light from said light-emitting layer in a direction through said substrate and said base", as recited in claims 14 and 19. As noted above, unlike conventional light-emitting devices in which the sealing resin in the dominant light-emitting path may become discolored due to heat generated by the light emitting element, and in which it is difficult to accurately fix the electrodes on the mounts of lead frames, the claimed invention includes a light-emitting element which may include a positive electrode including a light non-transmissible material, the electrode being disposed on an opposite side of the light-emitting layer from the substrate and reflecting light from the light-emitting layer in a direction through the substrate and the base (Application at Figure 1).

As noted above, this feature is important because it may help to prevent a sealing resin in the dominant light-emitting path from becoming discolored due to heat generated by the light emitting element (Application at page 6, lines 2-11). In addition, it allows a fluorescent material to be incorporated into the base to provide a light-emitting apparatus in which light of a constant color can be emitted for an extended period of time (Application at page 7, lines 18-23). In addition, this novel feature allows the use of bonding wires for connecting the electrodes of the light-emitting element to the bonding pads on the base. This allows the bonding pads to be formed on the base so as to maximize a distance between the lead frames, which facilitates attachment of the lead frames to the bonding pads (Application at page 6, line 12-page 7, line 17).

Clearly, Shimizu does not teach or suggest these novel which include the problems with heat-induced color change of sealing resin in the d features. Indeed, Shimizu does not address the problems that the claimed invention seeks to address ominent light-emitting path, and difficulty involved with accurately connecting electrodes to the lead frames.

Specifically, as noted above, Shimizu merely discloses sheet-like light source with a fluorescent layer 5 for producing a white light. Nowhere does Shimizu disclose a light emitting apparatus as in the claimed invention. Certainly, Shimizu does not disclose a light emitting apparatus having a light-emitting element with an electrode including a light non-transmissible material, the electrode being disposed on an opposite side of the light-emitting layer from the base and reflecting light from the light-emitting layer through the base. Therefore, Shimizu fails to make up for the deficiencies of Nemoto and Tsutsui.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. The Vriens Reference

The Examiner alleges that Vriens would have been combined with Nemoto and Tsutsui to form the claimed invention (e.g., as claimed in claim 20). Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Vriens discloses a light-emitting device which includes a UV/blue LED located in a depression having reflecting sidewalls, a light transmitting material surrounding the LED and filling the depression, and a phosphor in the form of particles either dispersed in the light transmitting material or adhered to the surface of the LED. The sidewalls reflect UV as well as visible light, thus enhancing the efficiency of the device. Optical filters located on the top of the LED and/or the bottom of a UV absorbing glass plate covering the depression further enhance efficiency and/or spectral characteristics of the emitted light (Vriens at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Specifically, as noted above, Nemoto is intended to address heat problems in a light-emitting device package, and Tsutsui is intended to improve the connection between electrodes on a light-emitting chip. In contrast, Vriens is directed to a device which converts blue light to visible light. Certainly, no person of ordinary skill in the art would have considered combining these references.

Further, the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner supports the combination by merely stating that “[i]t would have been obvious ... to include lead frames with large projections ... in Nemoto in view of Tsutsui so that the light from the LED device is centralized in one dominant direction” which is insufficient to support the combination.

Moreover, Applicant submits that Vriens does not teach or suggest “*a positive electrode comprising a light non-transmissible material, said electrode being disposed on an opposite side of said light-emitting layer from said substrate and reflecting light from said light-emitting layer in a direction through said substrate and said base*”, as recited in claims

14 and 19. As noted above, this feature is important because it may help to prevent a sealing resin in the dominant light-emitting path from becoming discolored due to heat generated by the light emitting element (Application at page 6, lines 2-11).

Clearly, Vriens does not teach or suggest these novel features. Indeed, Vriens does not discuss the problems that the claimed invention seeks to address which include the problems with heat-induced color change of sealing resin in the dominant light-emitting path, and difficulty involved with accurately connecting electrodes to the lead frames.

Specifically, the Examiner relies on Figure 1a in Vriens. However, Figure 1a shows a light-emitting diode (LED) 13 formed on a header 14 (Vriens at Figure 1a). The LED includes an anode 6 and a cathode 1, however, the cathode is not disposed between the light emitting layer (e.g., active layer 4) and the header 14 (Vriens at col. 3, lines 17-31). Further, as clearly indicated in Figure 1a, the dominant light-emitting direction is not through the header 14. Therefore, the LED in the Vriens device certainly does not include an electrode including a light non-transmissible material, the electrode being disposed on an opposite side of the light-emitting layer from the base and reflecting light from the light-emitting layer through the base.

In fact, Vriens device does not even disclose a “flip-chip” design. Instead, the leads 15, 16 and header 14 are integrally formed, and the LED 13 is formed on the header 14 on the side opposite to the leads 15, 16. Thus, the Vriens device is completely unrelated to the claimed invention which may have a flip-chip design. Therefore, Vriens fails to make up for the deficiencies of Nemoto and Tsutsui.

Therefore, Applicant respectfully submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 14-38, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance,

the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE**IN THE CLAIMS:****Please amend the claims to read as follows:**

14. (Thrice Amended) A semiconductor light-emitting apparatus of a flip chip bonding type, comprising:

a transparent base comprising [made of] an inorganic material, which has on one side thereof a first bonding pad and a second bonding pad to be connected to a pair of lead frames with a space between the first and the second bonding pads where a semiconductor light-emitting element is fixed, the light-emitting element comprising: [including]

a light-emitting layer;

a substrate disposed between said light emitting layer and said base; and

[a positive electrode that covers substantially an entire surface of a light-emitting layer of the light-emitting element, and the positive electrode reflecting light emitted from the light-emitting layer toward the light-emitting layer, such that the light passes through the substrate and the transparent base]

a positive electrode comprising a light non-transmissible material, said electrode being disposed on an opposite side of said light-emitting layer from said substrate and reflecting light from said light-emitting layer in a direction through said substrate and said base.

19. (Thrice Amended) A pair of lead frames for use in a light-emitting apparatus of a flip chip bonding type, said apparatus comprising:

a transparent base having [on] a first surface; [thereof a]

first and a second bonding pads formed on said first surface; [pad and]

a GaN semiconductor light-emitting device fixed on the first surface [thereof],

wherein a first lead frame [has] includes a first mount which faces [the] a dominant light emitting direction of the light-emitting apparatus and on which the first bonding pad is to be fixed, and a second lead frame [has] includes a second mount which faces the dominant light emitting direction and on which the second bonding pad is to be fixed,

wherein the light-emitting device comprises [including] a substrate, a light-emitting layer and [a positive electrode that covers substantially an entire surface of a light-emitting

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layer of the light-emitting device, and the positive electrode reflecting light emitted from the light-emitted layer toward the light-emitting layer, such that the light passes through the substrate and the transparent base] a positive electrode comprising a light non-transmissible material, said positive electrode being disposed on an opposite side of said light-emitting layer from said substrate and reflecting light from said light-emitting layer in a direction through said substrate and said base.

21. (Thrice Amended) A light-emitting diode comprising:

a sapphire substrate:

a light emitting layer made of GaN semiconductor and formed on said sapphire substrate; and

a positive electrode and a negative electrode electrically coupled to [formed on a surface of] said light emitting layer [on which the sapphire substrate is not formed];

wherein[:]said positive electrode and said negative electrode are supplied with electricity through a wire; and

wherein said positive electrode has a thickness of at least 300 Å, comprises a light non-transmissible material for reflecting light from said light emitting layer toward said sapphire substrate, and covers substantially an entire surface of the light-emitting layer.

Please add the following new claims:

- - 26. A semiconductor light-emitting apparatus comprising:

a base;

first and second bonding pads formed on a first surface of said base;

a light-emitting element formed between said first and second bonding pads on said first surface of said base, said light-emitting element comprising:

a substrate;

a light-emitting layer formed on said substrate; and

a first electrode disposed on an opposite side of said light-emitting layer from said base and reflecting light from said light-emitting layer through said base; and

a fluorescent material which is adjacent to said substrate and on an opposite side of said substrate from said light-emitting layer.

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27. The semiconductor light-emitting apparatus according to claim 26, further comprising:

first and second lead frames electrically connected to said first and second bonding pads, respectively.

28. The semiconductor light-emitting apparatus according to claim 27, wherein said light-emitting element further comprises a substrate disposed between said light-emitting layer and said base, and wherein said first electrode reflects light from said light-emitting layer through said substrate.

29. The semiconductor light-emitting apparatus according to claim 27, wherein a direction from said light-emitting layer toward said base comprises a dominant light-emitting direction.

30. The semiconductor light-emitting apparatus according to claim 29, wherein said first and second lead frames each comprise a projecting portion which reflects light in said dominant light-emitting direction.

31. The semiconductor light-emitting apparatus according to claim 27, wherein said first and second bonding pads are formed on said first surface of said base so as to maximize a distance between said first and second lead frames.

32. The semiconductor light-emitting apparatus according to claim 26, wherein first and second bonding pads are formed on opposing outer edges of said first surface of said base.

33. The semiconductor light-emitting apparatus according to claim 26, wherein an adhesive adheres said light-emitting element to said first surface of said base.

34. The semiconductor light-emitting apparatus according to claim 26, wherein said light-emitting element further comprises a second electrode, said first and second electrodes being connected by bonding wires to said first and second bonding pads, respectively.

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35. The semiconductor light-emitting apparatus according to claim 34, wherein said first and second lead frames and said bonding wires are connected to a same surface of said first and second bonding pads.

36. The semiconductor light-emitting apparatus according to claim 28, wherein said substrate of said light-emitting element is formed on said base.

37. The semiconductor light-emitting apparatus according to claim 14, further comprising:

a fluorescent material which is adjacent to said substrate and on an opposite side of said substrate from said light-emitting layer.

38. The pair of lead frames according to claim 19, wherein said apparatus further comprises a sealing resin formed over said transparent base and said GaN semiconductor light-emitting device. - -